Acetazolamide or Not, Prior To Ascent?

MAJ Stephen M. DeLellis MPAS, PA-C

ABSTRACT

Special Operation Soldiers must be prepared to work in all environmental extremes, frequently with little or no preparation time. While working in extreme heat or cold is uncomfortable, little preparation is necessary as long as reasonably fit Soldiers remain properly nourished, hydrated, or clothed. Working at high altitude poses additional risks that can be pharmacologically mitigated. While new prophylactic therapies are appearing on the scene in mountaineering and high-altitude climbing circles, acetazolamide still appears to be the preferred drug for the prevention of altitude related illness.

Each climbing season alpinists around the world attempt to tackle the highest summits on the face of the earth. Many of them cling to traditional training methods, using prophylactic medications and dietary supplements to enhance their odds of success. Occasionally, the military and the Special Operations community must work at physiologically challenging altitudes, sometimes for prolonged periods. There is good anecdotal evidence supporting traditional use of prophylactic acetazolamide prior to and during ascent for the prevention of high altitude syndromes.

In January 2010 an expedition of 20 healthcare providers attempted to climb Cerro Aconcagua in Argentina. Among the expedition members were three Special Operations healthcare providers including two physicians and a physician assistant. Standing 22,841 feet tall (6962m), Aconcagua is the highest peak in the world outside of the Himalayas.

Statistically, a smaller percentage of climbers successfully summit Aconcagua each climbing season than reach the summit of Mt Everest. While most climbers train extensively and prepare well in advance for an Everest attempt, many consider Aconcagua a "beginner's mountain". Since there is a non-technical route to Aconcagua's summit (the Aconcagua Normal Route), many assume that they can simply "hike" to the summit. However, the fact remains that Aconcagua's summit rests at 22,841 feet tall; due to its latitude, the summit is ravaged by foul weather, deep snow and high winds even during the summer-only climbing season (typically December through February). On summit day the team enjoyed temperatures of minus 27 degrees Fahrenheit (2.8C), a steady 35 knot wind and over a foot of fresh snow.

The expedition ascended at a very conservative rate over 10 days, with several rest days and day-hikes to higher altitudes for acclimatization. Daily health checks were performed on each expedition member by their guides. Each member's blood oxygen saturation (SaO_2) and pulse were checked daily. Any symptoms of ill health, including headache, nausea, vomiting, diarrhea, and cough, as well as medication and doses were recorded for each member daily. Despite the conservative pace, the team lost four of the twenty members to acute mountain sickness (AMS), high altitude pulmonary edema (HAPE), high altitude cerebral edema (HACE) or gout prior to reaching Camp-2 (Camp Nido de Condores) at 17,582 feet (5359 m). At Camp-2 an additional member was evacuated due to a spontaneous retinal detachment. Unfortunately, the records for those five expedition members were evacuated with the victims.

Of the fifteen remaining climbers, six successfully reached the summit. A review of the medical data showed that those who reached the summit took an average dose of 168.7mg of acetazolamide, while those who did not reach the summit took an average of 95.5mg daily. The symptom score over ten days for those who reached the summit was 29 compared with 42 symptoms among the non-summiteers. There was little difference in average SaO_2 and pulse between groups. The successful group had an average SaO_2 and pulse of 83.3% and 86 beats per minute (bpm) respectively, while the unsuccessful group had an average SaO_2 of 82.5% and a pulse of 84.5 bpm.

Interestingly, each group had a member with high altitude bronchitis (HAB): the successful 44 year-old male member, who took acetazolamide as recommended, had an average SaO_2 and pulse of 82% and 98.6 bpm respectively, with a symptom score of 11; while the unsuccessful 43 year-old female member, who took no acetazolamide, had an average SaO_2 and pulse of 79.2% and 83.3 bpm, and a symptom score of 10. The average age of those who reached the summit was 42 years, while the average age of those that did not reach the summit was 37 years.

Symptom scores were based on daily data collection by the guides. Each member was asked if they were currently experiencing, or had experienced cough, headache, nausea, vomiting, malaise, or decreased appetite in the last 24 hours. Of the six successful members, five reported at least two symptoms during the 10-day expedition, with an average of 4.8 symptoms per member. One successful member had a symptom score of zero. All unsuccessful members reported at least two symptoms over the 10 days, with an average of 4.9 symptoms. Incidentally, both members with HAB claimed cough as a symptom on all 10 days; their symptom scores alone accounted for 30% of all reported symptoms throughout the expedition.

While physiologic changes in blood oxygen saturation and pulse rate, and average symptom scores were similar in both groups, there was a significant difference in prophylaxis between the successful group and those who

Successful Members

Acetazolamide			Symptoms								
Avg daily mg dose	Daily freq.	Duration in days	Headache	Nausea	Vomiting	Diarrhea	Cough	Anorexia	Malaise/ Fatigue	Heart rate	O2 Sat
62.5	QD	6	3	0	0	2	0	0	8	94.7	86.7
125	QD	10	1	0	0	0	10	0	9	83.7	84.7
225	BID	10	4	0	0	1	0	0	8	75	82.6
187.5	BID	10	0	0	0	0	0	0	0	80.9	84.8
200	BID	10	0	0	0	2	9	0	7	98.6	82
250	BID	10	0	0	0	1	1	0	5	83.3	79.2

Unsuccessful Members

Acetazolamide			Symptoms								
Avg daily mg dose	Daily freq.	Duration in days	Headache	Nausea	Vomiting	Diarrhea	Cough	Anorexia	Malaise/ Fatigue	Heart rate	O2 Sat
156.25	BID	8	2	0	0	0	1	0	3	80	89.4
0	n/a	0	3	0	0	3	0	0	3	79.9	79.8
125	QD	5	1	0	0	1	1	0	3	92.8	87.2
225	BID	9	2	0	0	2	2	3	6	89.4	80.7
125	QD	10	3	0	0	2	2	0	7	85	81.6
0	n/a	0	0	0	0	0	0	2	10	75.8	79.1
81.25	QD	9	1	0	0	1	1	2	8	91.8	84.2
87.5	QD	8	1	0	0	1	1	0	2	74.1	86
75	QD	9	1	0	0	2	2	1	6	89.7	82.4

failed to reach the summit. All members who reached the summit took acetazolamide. Four of the six successful members took a twice daily dose; one member took a single daily dose. Five of the six successful members began prophylaxis below 11,000 feet (3353m) and one member began at Camp Confluencia at 11,112 feet (3387m). Of the nine that did not summit, two took no acetazolamide, five members took it once daily and two took it twice daily. None of the successful members skipped doses, while five of the seven unsuccessful members who took acetazolamide skipped at least one dose.

The CDC and the Institute for Altitude Medicine at Telluride recommends 125mg of acetazolamide twice daily, beginning the day prior to ascent and continuing that dosing schedule through the second day at the highest sleeping altitude, as the drug of choice. (http://www.altitudemedicine.org/providers.php). The Centers for Disease Control's (CDC) Yellow Book explains that acetazolamide works by acidifying the blood, thereby increasing the rate of respiration, resulting in improved acclimatization. While allergic reactions to acetazolamide are rare, patients who have sulfa or penicillin allergies may have an allergic reaction to acetazolamide. (http://wwwnc.cdc.gov/travel/yellowbook/2010/chapter-2/altitude-illness.aspx).

While new prophylactic medications and supplements, such sildenafil and ginko biloba, are becoming more commonplace in mountaineering and high-altitude climbing circles, acetazolamide still appears to be the preferred drug for the prevention of altitude related illness. This data suggests that those climbers that took acetazolamide at the recommended dosing schedule were better prepared to fend off the ill-effects of altitude. For example, those that took reg-

ular doses of acetazolamide, at or near the recommended dose of 125mg twice daily, had a greater chance of success at reaching the summit despite differences in age or pre-existing illness, than those who did not take acetazolamide or skipped doses (six successful versus fourteen unsuccessful).

All of our expedition members were in average shape for their age. A few were experienced and accomplished alpinists and a few were altitude naïve. One of our more experienced members that failed to summit spends a significant part of each year at 17,000 feet in the Himalayas. She was not taking acetazolamide. One successful team member, whose climbing experience was all sea-level, technical rock climbing had never been to altitude greater than that of a pressurized commercial airplane. He was taking the recommended 125mg of acetazolamide twice daily.

Acetazolamide is a reasonable choice for prophylaxis for even short trips to altitude. The ability to begin dosing the day prior to ascent makes acetazolamide a good choice even for unplanned or spontaneous forays to altitude. The members of the expedition who took acetazolamide at or near the recommended prophylactic dose and were compliant in their dosing schedule, including a team-mate with a pre-existing upper respiratory infection, were successful. The members of the expedition who opted to not take acetazolamide, skipped doses, or took sub-therapeutic doses failed to summit. Our expedition was not intended to serve as a study of acetazolamide as a prophylaxis for altitude sickness. However, our statistics favor acetazolamide as a reasonable choice for those that must work at altitude.

Special thanks to Dr. Andre Pennardt; mentor, friend, climbing partner and editorial reviewer. Likewise, special thanks to Dr. J. Craig Taylor for his editorial review.

Photo 1: *The author and team-mates on summit day*

Photo 3: *The author on summit day*

Photo 2: *High Camp at 19,000 ft*

MAJ Steve DeLellis is an Army Physician Assistant currently serving with the Army Special Operations Command (USASOC). Steve is a former Special Forces medic (18D). Previous assignments include the 82nd Airborne Division, the 1st Bn 75th Ranger Regiment, 3rd Bn, 3rd Special Forces Group and several assignments within USASOC. His operational experience includes tours in Panama (Just Cause), the Philippines, Somalia (UNOSOM II), Haiti (Restore Hope), Serbo-Croatia, Afghanistan (OEF), and Iraq (OIF). Steve recently returned from his 11th tour in Iraq.